Policy Biases When the Monetary and Fiscal Authorities Have Different Objectives

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Until recently, the debate on the relationship between monetary and fiscal authorities centered on the inflationary consequences of monetary financing of the fiscal deficit. The moderately high inflation of the 1970s in some industrialized countries and, particularly, the recurring episodes of very high inflation in several developing countries justified this focus. The main policy recommendation for countries seeking to avoid high and variable inflation has been to institute an independent monetary authority whose main mandate is the control of inflation (see Cukierman, 1992; Walsh, 1993). In fact, in recent years several central banks around the world have adopted inflation targeting as the cornerstone of their monetary policy (see Bernanke and others, 1999).

For their part, fiscal authorities in many countries have also come to recognize the harmful effects of inflation and have taken measures to control their deficits. This has been achieved both by rationalizing fiscal expenditure (for example, eliminating price subsidies and privatizing public enterprises) and by raising tax revenue, particularly through the adoption of value-added taxes. Fiscal authorities are also using domestic and international financial markets to better manage the public debt, to avoid the need to collect an inflation tax from outstanding monetary assets.

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Thus, in many countries around the world, there is a new policy environment, one in which monetary authorities are committed to controlling inflation, and fiscal authorities do not rely on the inflation tax to finance their deficits and debt service. In this new context, a different set of policy issues and questions arises. This paper is devoted to one of these, namely, what effect a lack of coordination between monetary and fiscal authorities has in achieving the goal of minimizing business cycle fluctuations.

Coordination (or the lack thereof) is a relevant issue because monetary and fiscal authorities have different policy instruments, different objectives and preferences, and sometimes different perceptions of how the economy functions. In this paper we concentrate on the effects of having monetary and fiscal authorities with dissimilar objectives and with control of different policy instruments. In this sense the paper is closely related to Nordhaus (1994), Loewy (1988), and Perry and Lederman (1997). Following these studies, we use a game-theoretic approach to analyze the effects of a lack of policy coordination on fiscal deficits and domestic real interest rates.

To introduce the main issues and results of the paper, we present a simple fiscal-monetary game modeled after the well-known prisoners' dilemma. We use this game to analyze the possible responses of the monetary and fiscal authorities in the face of a negative shock that raises inflation and lowers employment. Figure 1 presents the main assumptions and the outcomes. The monetary and the fiscal authorities each have two options: they can follow either a loose or a tight policy. When both "play tight," the resulting inflation is low, but so is the resulting employment. When both play loose, both inflation and employment are high. And when only one of them plays tight and the other loose, the result is employment and inflation that are somewhere in between.

The interesting feature of this fiscal-monetary game is that the two authorities have different preferences for both inflation and employment (see the payoff schedules in figure 1). Whereas the monetary authority places greater value on achieving low inflation than on achieving high employment, the fiscal authority regards the latter as more important than keeping inflation low. (We have arbitrarily made these differences in the preference schedules sufficiently large to obtain the result we would like to stress.)

The only Nash equilibrium in this game consists of a tight monetary policy and a loose fiscal policy. All of the other alternatives present opportunities for one of the players to benefit by unilaterally deviating from it. Thus the equilibrium of this game exposes the paradigmatic conservatism of central banks and liberalism of fiscal authorities. It also illustrates why the response of each of them is optimal given their differing preferences. If the monetary authority were to follow a loose policy and accept a pledge from the fiscal authority for stricter restraint, the fiscal authority would find it optimal to renege on its pledge and adopt a loose policy. By the same token, if the fiscal authority were to conduct a tight policy, given an offer from the central bank to follow a loose policy, the monetary authority would benefit by deviating from its offer and following a tight policy instead. Finally, in terms of the payoffs to both authorities, the Nash equilibrium is equivalent to the combination of loose monetary and tight fiscal policies. From a long-run perspective, however, it can be argued that this combination of policies is healthier than the Nash equilibrium, given that it does not compromise fiscal sustainability and does not weaken the investment capacity of the private sector.

Figure 1. A Monetary-Fiscal Game: Outcomes and Payoffs

Central bank

		Tight monetary policy	*Loose monetary policy*
Fiscal authority	*Tight fiscal policy*	*Outcome*: Low inflation Low employment *Payoff*: Central bank: 6 + 1 = 7 Fiscal authority: 3 + 1 = 4	*Outcome*: Medium inflation Medium employment *Payoff*: Central bank: 4 + 2 = 6 Fiscal authority: 2 + 4 = 6
	Loose fiscal policy	*Outcome*: Medium inflation Medium employment *Payoff*: Central bank: 4 + 2 = 6 Fiscal authority: 2 + 4 = 6	*Outcome*: High inflation High employment *Payoff*: Central bank: 1 + 3 = 4 Fiscal authority: 1 + 6 = 7

Payoff schedule

	Low	*Medium*	*High*
		Inflation	
Central bank	6	4	1
Fiscal authority	3	2	1
		Employment	
Central bank	1	2	3
Fiscal authority	1	4	6

Although it illustrates the major themes of the paper, this simple game has some obvious shortcomings. One is that it requires an arbitrary, ad hoc payoff schedule to achieve the desired result. We may want to clarify the preference conditions under which policy biases occur. The second shortcoming is that the game does not consider the possibility for negotiation between the fiscal and monetary authorities, which may result in policy coordination.

Section 1 of this paper presents a more fully elaborated monetary-fiscal game in which the potential advantages of policy coordination can be clearly seen. Through this model we also clarify the conditions under which looser fiscal policy (represented by higher primary fiscal deficits) is accompanied by tighter monetary policy (represented by higher real interest rates), as predicted by our version of the prisoners' dilemma. Our basic conclusion from the model is that increasing the divergence in preferences between the monetary and fiscal authorities for output and inflation gaps results in higher primary fiscal deficits and higher real interest rates.

Section 1 also compares the Nash equilibrium solution to this model with a Stackelberg solution. By allowing one of the authorities to take the lead in choosing policy, the Stackelberg solution introduces a dynamic dimension into the game, creating the possibility for one player (the leader) to act in a way that elicits a mutually beneficial response from the other (the follower). The Stackelberg game results in the same basic conclusion as the Nash equilibrium; however, due to its potential for beneficial interaction, the Stackelberg equilibrium comes closer to the coordination solution than the Nash equilibrium does.[1]

Section 2 brings some empirical evidence to bear on the question. We use annual data over the period 1970-94 from a sample of industrialized countries to test the main hypothesis of our model: in a context where fiscal and monetary authorities are independent and do not effectively coordinate their policy responses, those countries whose fiscal and monetary authorities have more divergent preferences for the output and inflation gaps will exhibit larger primary deficits and higher real interest rates. Given the simplified nature of

1. We acknowledge that the coordination solution against which we compare the Nash and Stackelberg equilibria is not derived endogenously in the model. This is because the game we analyze is a "one-shot" game. Endogenous coordination, which is beyond the scope of this paper, may arise in the context of a game played in a series of consecutive rounds, where the coordination solution would be sustained by reputation, commitment, and credibility.

our game-theoretic model, this conclusion would apply only after controlling for other factors affecting the level of primary deficits and domestic real interest rates.

We run separate regressions for the primary deficit (as a ratio to GDP) and the real domestic interest rate (more precisely, its deviation from the international interest rate). Then we assess whether proxies for the divergence in preferences between fiscal and monetary authorities are positively related to these primary deficits and real interest rates. The proxies we use are indexes for each country of the importance of price stability for the central bank. In these regressions we control for a number of effects that may influence (or be influenced by) the dependent variables, such as business cycle effects, international conditions, and Ricardian equivalence effects.

Using a seemingly-unrelated-regression estimator and accounting for country random effects, we find that, ceteris paribus, the greater the importance placed on inflation control by the monetary authority, the larger is the primary deficit and the higher the domestic real interest rate. We conclude that, without prejudice to the gains from central bank independence, there are gains to be had from policy coordination by the monetary and fiscal authorities. Central bank independence has helped achieve price stability and has induced fiscal discipline in many countries. As mentioned above, this is a necessary, first-generation reform. A policy implication of this paper is that a second-generation reform consisting of institutional incentives for domestic policy coordination can also be beneficial, but only for countries that have already achieved price stability and fiscal discipline.

1. A Game-Theoretic Model

This section presents a one-period model of a simple game played by monetary and fiscal authorities. It builds on the tradeoff that each authority has to face in the short run between changes in the inflation rate and in the output gap (that is, the Phillips curve). The model emphasizes the effects on the level of fiscal deficits and real interest rates that result from different preferences by the monetary and fiscal authorities with respect to deviations of inflation and output from their optimal levels.

This game-theoretic approach is based on Frankel (1988), Loewy (1988), and Nordhaus (1994). The main difference between Frankel's model and ours is that Frankel assumes a world where the authorities have the same preferences with respect to inflation and output deviations but disagree on the model that best represents the economy.[2] With respect to Nordhaus's model, the main difference is that we assume that the monetary authority dislikes changing the real interest rate from its optimal level. As we show below, under this assumption it is possible to reverse Nordhaus's conclusion that lack of coordination between monetary and fiscal authorities necessarily implies higher fiscal deficits and higher real interest rates. Also, extending Nordhaus's work, we analyze the Stackelberg equilibrium, which allows us to assess whether the main conclusions change if the monetary-fiscal game is played sequentially. Two other important differences with respect to previous work are that, first, we assume asymmetric preferences and, second, we analyze aggregate supply and demand shocks separately (the latter are presented in an earlier version of this paper: Bennett and Loayza, 2000).

1.1 The Model

We assume that policymakers seek to maximize an asymmetric utility function. Both fiscal and monetary authorities dislike falls in output and rises in inflation; however, they do not mind rises in output or drops in inflation. In addition, we assume that each authority dislikes changing its policy instrument from its equilibrium level.

The utility level for the fiscal authority is denoted by U^F, and its relative preference between objectives is given by the coefficients α^F, β^F, and δ. These measure, respectively, the cost associated with output falling below a certain threshold $(y - y^*)$, with inflation rising beyond a desired level $(\pi - \pi^*)$, and with deviations of the deficit from a socially optimal level $(D - D^*)$.

$$U^F = V^F\left[(y - y^*), (\pi - \pi^*), (D - D^*)\right],$$

$$U^F = -\alpha^F\left[\min\left(y - y^*, 0\right)\right]^2 - \beta^F\left[\max\left(\pi - \pi^*, 0\right)\right]^2 - \delta\left(D - D^*\right)^2. \tag{1}$$

Note that $\alpha^F, \beta^F, \delta > 0$.[3]

2. Frankel concludes that policy coordination may not be welfare improving if it means a departure from the "true" model. However, coordination is more likely to be welfare improving if it involves sharing information so as to arrive at that "true" model.

3. More precisely, D represents the primary deficit (the overall deficit minus interest payments).

The monetary authority's utility function is modeled with the same structure, but instead of the deficit deviation it has an intrinsic preference with respect to its instrument, the real interest rate (r). Analogously to equation (1), U^M represents the monetary authority's utility, and α^M, β^M, and τ measure, respectively, the cost associated with output falling below a certain threshold ($y - y^*$), with inflation rising beyond a desired level ($\pi - \pi^*$), and with deviations of the real interest rate from its socially optimal level ($r - r^*$).

$$U^M = V^M\left[\left(y - y^*\right), \left(\pi - \pi^*\right), \left(r - r^*\right)\right],$$

$$U^M = -\alpha^M\left[\min\left(y - y^*, 0\right)\right]^2 - \beta^M\left[\max\left(\pi - \pi^*, 0\right)\right]^2 - \tau\left(r - r^*\right)^2. \quad (2)$$

Again, $\alpha^M, \beta^M, \tau > 0$.

The assumption that $\tau > 0$ reflects the observation that central banks dislike large and sudden movements in policy interest rates. For example, in the recent literature on monetary policy, the lagged interest rate has been widely used as an argument of the policy reaction function (see Woodford, 1999, for a model that formalizes the optimality of interest rate smoothing rules). Similarly, the assumption that $\delta > 0$ reflects the fact that the fiscal authorities dislike deviations in their instrument from an established target. This may result from the political costs and financing difficulties involved in moving away from an agreed-upon fiscal budget.

We assume that the monetary authority cares more about a rise in inflation than the fiscal authority does. Conversely, the fiscal authority is more concerned about drops in output than its monetary counterpart is. That is, $\beta^M > \beta^F$ and $\alpha^F > \alpha^M$. These divergent preferences reflect both the central bank's mission to contain inflation and the fiscal authority's need to deal with voters' aversion to unemployment. We assume that the socially optimal levels y^*, π^*, D^*, and r^* are perceived to be the same by both authorities.

The forces that rule the economy are modeled as follows:

$$y - y^* = \gamma_D\left(D - D^*\right) - \gamma_r\left(r - r^*\right) + \gamma_0, \quad (3)$$

$$\pi - \pi^* = \lambda_y\left(y - y^*\right) - \lambda_0. \quad (4)$$

Equation (3) gives the aggregate demand function, and equation (4) gives aggregate supply (or the Phillips curve). The term $(y - y^*)$ represents the output gap; $(\pi - \pi^*)$ represents the deviation of inflation from the optimal rate; γ_D and γ_r represent, respectively, the elasticity of the output gap with respect to fiscal deficits and the real interest rate; and λ_y represents the elasticity of inflation with respect to the output gap. Shocks to aggregate demand and supply are represented, respectively, by γ_0 and λ_0. For simplicity, we set D^*, $r^* = 0$.

In what follows we concentrate on aggregate supply shocks, which in our model create a trade-off between output and inflation for both authorities. In Bennett and Loayza (2000) we study the fiscal and monetary response to aggregate demand shocks and show that the central hypothesis of the model, tested in section 2 of this paper, holds for this type of shock as well.

The solution for the case of a positive aggregate supply shock ($\lambda_0 > 0$) is trivial. This results from the type of asymmetric loss functions that we have assumed. A positive supply shock leaves inflation lower than π^* and output higher than y^*, in which case neither authority suffers a loss, and thus there is no policy response. On the other hand, a negative supply shock lowers output and increases inflation, thus inducing a policy reaction by both authorities. It is this case that we study in detail.

Given a negative supply shock, the loss functions in equations (1) and (2) can be written as follows:

$$U^F = -\alpha^F \left(y - y^*\right)^2 - \beta^F \left(\pi - \pi^*\right)^2 - \delta\left(D - D^*\right)^2, \tag{5}$$

$$U^M = -\alpha^M \left(y - y^*\right)^2 - \beta^M \left(\pi - \pi^*\right)^2 - \tau\left(r - r^*\right)^2. \tag{6}$$

This simplification is correct because, as we show below, the resulting equilibrium level of output is lower than y^*, and inflation is higher than π^*. In other words, the solution is interior to the range $y < y^*$ and $\pi > \pi^*$.

1.2 Optimization under a Single Economic Authority

First we determine the optimal levels of D and r in the two cases where the monetary or the fiscal authority is able by itself to determine both instruments (in other words, there is a single economic authority). This will give us their respective "bliss points." We can then compare the situation where each authority determines its own instrument under lack of coordination with alternative scenarios such as, first, a single economic authority managing both monetary and fiscal policies, and, second, the two authorities working to coordinate policy.[4]

When the fiscal authority also determines the interest rate, the first-order conditions are

$$\frac{\partial U^F}{\partial D} = -2\alpha^F \left(y - y^*\right)\gamma_D - 2\beta^F \left(\pi - \pi^*\right)\lambda_y\gamma_D - 2\delta D = 0 \ , \tag{7}$$

$$\frac{\partial U^F}{\partial r} = 2\alpha^F \left(y - y^*\right)\gamma_r + 2\beta^F \left(\pi - \pi^*\right)\lambda_y\gamma_r = 0 \ . \tag{8}$$

From equation (7), and substituting equations (3) and (4), we obtain the fiscal reaction function (FRnFn):

$$D = \left[\frac{1}{1 + \dfrac{\delta}{\gamma_D^2 \left(\alpha^F + \beta^F\lambda_y^2\right)}}\right]\frac{\gamma_r}{\gamma_D}r + \left[\frac{\lambda_y\lambda_0}{\dfrac{\delta}{\beta^F\gamma_D} + \gamma_D \left(\alpha^F/\beta^F + \lambda_y^2\right)}\right]. \tag{9}$$

From equation (8) we obtain what we call the fiscal cross-maximization function (FCrMx), because it results from the fiscal authority's optimization with respect to the instrument of the other (monetary) authority (the real interest rate):

$$D = \frac{\gamma_r}{\gamma_D}r + \left[\frac{\lambda_y\lambda_0}{\gamma_D \left(\alpha^F/\beta^F + \lambda_y^2\right)}\right]. \tag{10}$$

Figure 2 plots equations (9) and (10). Their intersection gives the optimal pair (D^F, r^F), or bliss point, for the fiscal authority. This is

4. By coordination we mean a process through which the two independent authorities negotiate their strategies in order to improve the results for both.

achieved at the fiscal authority's optimal level of aggregate demand, with $D^F = 0$. This result is to be expected given the fiscal authority's dislike of having the public deficit deviate from its optimal level. From the fiscal authority's utility function in equation (5) we can see that it is costless to this authority to achieve the optimal aggregate demand level using r instead of D as the policy instrument.

The dotted lines in figure 2 and the figures that follow represent iso-aggregate demand levels (iso-AD). The slope of the aggregate demand function is γ_r/γ_D. From equation (10), the slope of FCrMx is γ_r/γ_D, so this line also represents an aggregate demand level, which in this case is the optimal fiscal activity level.

Analogously, we can obtain the monetary authority's bliss point. When the central bank determines both D and r, the first-order conditions are derived by maximizing the central bank's utility function in equation (6) with respect to both instruments. The monetary reaction function (MRnFn) is given by

$$\frac{\partial U^M}{\partial r} = 0 \Rightarrow$$

$$D = \left[1 + \frac{\tau}{\gamma_r^2\left(\alpha^M + \beta^M \lambda_y^2\right)}\right]\frac{\gamma_r}{\gamma_D} r + \left[\frac{\lambda_y \lambda_0}{\gamma_D\left(\alpha^M/\beta^M + \lambda_y^2\right)}\right], \tag{11}$$

and the monetary cross-maximization (MCrMx) function is given by

$$\frac{\partial U^M}{\partial D} = 0 \Rightarrow$$

$$D = \frac{\gamma_r}{\gamma_D} r + \left[\frac{\lambda_y \lambda_0}{\gamma_D\left(\alpha^M/\beta^M + \lambda_y^2\right)}\right]. \tag{12}$$

The monetary authority's bliss point, (D^M, r^M), is obtained in the same way as for the fiscal authority. Its optimal aggregate demand level is reached with its instrument unchanged, $r = 0$. Figure 2 shows that the level of aggregate demand at the monetary bliss point is lower than that reached at the fiscal bliss point. This comes from the relationship between α^F/β^F and α^M/β^M, the authorities' relative preferences for inflation and output ($\alpha^F/\beta^F > \alpha^M/\beta^M$).[5]

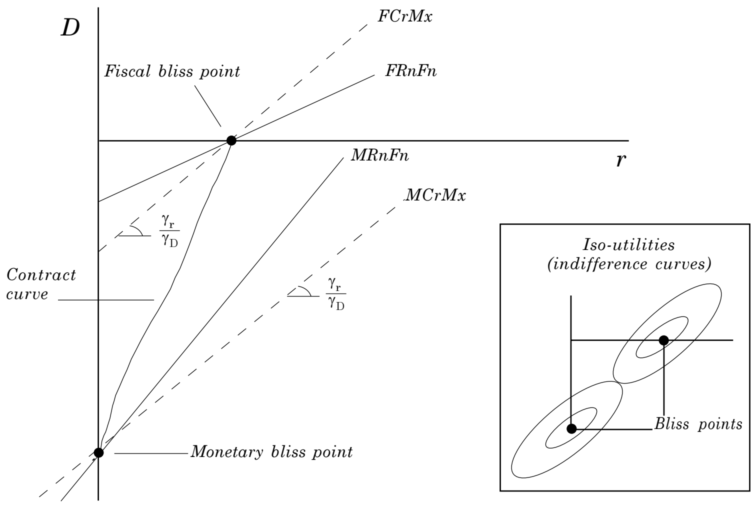
5. Remember that the dotted lines represent iso-AD curves. In this case, the MCrMx function in equation (12) gives the bliss level of aggregate demand for the monetary authority.

What happens if the monetary authority presents a greater disutility from higher inflation (that is, a higher β^M)? The central bank's optimal aggregate demand will then decrease in order to achieve lower inflation. As discussed above, this change in the bliss point represents a downward movement along the *D* axis.

To summarize, these two simple scenarios of nonindependence (a single economic authority) show the effects on activity of different preferences in each authority's utility function. They also show the desire of each authority to use the other's instrument to adjust the output and inflation gaps and thus optimize its own utility function.

In addition to these cases of nonindependence, it is interesting to study the case where there is coordination between independent authorities. The contract curve shown in figure 2 describes the possible solutions for this scenario. It is the group of points for which there is no possibility of improving the situation of one authority without diminishing the utility of the other. In other words, the contract curve is the line that contains the tangent points between the two sets of iso-utility curves (see inset in figure 2).[6]

Figure 2. Fiscal and Monetary Bliss Points and the Contract Curve



6. The shape of the iso-utility curves depends on the authorities' utility function parameters: the relative preference for inflation and output gaps, and the relative cost associated with deviations of the respective instrument.

Even though, with independent authorities, points on the contract curve seem to be the best solution for both players, this coordinated equilibrium may be unenforceable and thus unlikely to be achieved. In the real world, the fact of independence, together with obstacles to enforcing commitments, the transactions costs that hinder coordination, and the practical inability to discern outcomes due to policies from those due to shocks, suggests that policy actions may be more realistically modeled as Nash or Stackelberg games.

1.3 The Nash Equilibrium

The Nash equilibrium applies when both players decide their strategies simultaneously and without coordination. In the monetary-fiscal game, this means that each authority has to decide the level of its instrument, knowing that its counterpart is rational and has a certain preference regarding the inflation and output gap. Then the Nash equilibrium will result in a pair (D^N, r^N) in which no player can reach a higher utility level by unilaterally deviating from that equilibrium.

The Nash solution is obtained when each authority maximizes its utility function with respect to its own instrument, taking the other policy instrument as given. Equations (7) and (11) represent the first-order conditions of the Nash solution. Thus, the reaction function of the fiscal authority is given by equation (9), and the monetary authority's reaction function by equation (11).

Comparing these two equations shows that, first, the slope of MRnFn is greater than γ_r/γ_D, and the slope of FRnFn is less than γ_r/γ_D , which reflects the loss associated with each authority allowing its respective policy instrument to deviate from its optimal level. Second, the intercept of MRnFn is more negative than that of FRnFn, which results from the fact that the monetary authority realizes a smaller loss from a given output gap (and a greater loss from a given inflation gap) than the fiscal authority (figure 3).

The intersection of MRnFn and FRnFn gives the Nash solution. After a fair amount of algebra, the solution of the Nash equilibrium is given by

$$D^N = \frac{-\gamma_r^2\lambda_y\left(\alpha^F\beta^M - \alpha^M\beta^F\right)\lambda_0 + \tau\beta^F\lambda_y\lambda_0}{\gamma_r^2\delta/\gamma_D\left(\alpha^M + \beta^M\lambda_y^2\right) + \tau\delta/\gamma_D + \gamma_D\tau\left(\alpha^F + \beta^F\lambda_y^2\right)}\ , \tag{13}$$

$$r^N = \frac{-\gamma_D^2\lambda_y\left(\alpha^F\beta^M - \alpha^M\beta^F\right)\lambda_0 - \delta\beta^M\lambda_y\lambda_0}{\gamma_r\delta\left(\alpha^M + \beta^M\lambda_y^2\right) + \tau\delta/\gamma_r + \gamma_D^2\tau/\gamma_r\left(\alpha^F + \beta^F\lambda_y^2\right)}\ . \tag{14}$$

Note from equation (13) that the sign of D^N is not strictly positive. In fact, D^N will be negative if the difference in preferences between monetary and fiscal authorities is small with respect to the central bank's loss from changing the interest rate from its target level. This case, however, is of limited empirical importance, because it would imply that, in the presence of a negative supply shock, central bank independence results in higher inflation than under the fiscal bliss point (figure 4). This makes little practical sense. Therefore in what follows we assume that the condition given in equation (15) holds, so that the Nash equilibrium always implies a larger deficit and a higher real interest rate than the solution under a single economic authority. Intuitively, this condition requires that the central bank values low inflation sufficiently more than the fiscal authority and sufficiently more than keeping the interest rate at its long-run level:

$$\alpha^F \beta^M - \alpha^M \beta^F > \tau \frac{\beta^F}{\gamma_r^2} \cdot \tag{15}$$

The Nash equilibrium portrayed in figure 3 represents the conclusion arrived at in Loewy (1988) and in Nordhaus (1994): both the real interest rate and the fiscal deficit exceed their levels at either bliss point. In fact, the level of aggregate demand obtained at the Nash equilibrium can be achieved by a large number of combinations of lower deficits and interest rates. Thus the Nash equilibrium (D^N, r^N) is Pareto inferior to a large set of points, and in particular to any point on the contract curve.

Why does this "inefficiency" occur? The following example, presented in the inset in figure 3, may clarify the intuition behind this result. Starting from the fiscal bliss point (D^F, r^F), suppose that the central bank is granted independence and that no coordination is possible. The monetary authority could react to the initial level of aggregate demand by increasing r to a new level, allowing it to maximize its utility function for the fiscal deficit $D = 0$ (point 1). A rational fiscal authority will anticipate this reaction and the level of aggregate demand that it implies, and thus it may react with a level of D that maximizes its own utility function given the new real interest rate (point 2). The monetary authority, in turn, may reset its instrument to a new optimal level given the latest fiscal reaction (point 3). As the figure shows, each authority will continue to adjust its policy instrument until neither can improve its utility, given rational behavior by the other player. This equilibrium is represented by the optimal pair (D^N, r^N).

Figure 3. Nash Equilibrium

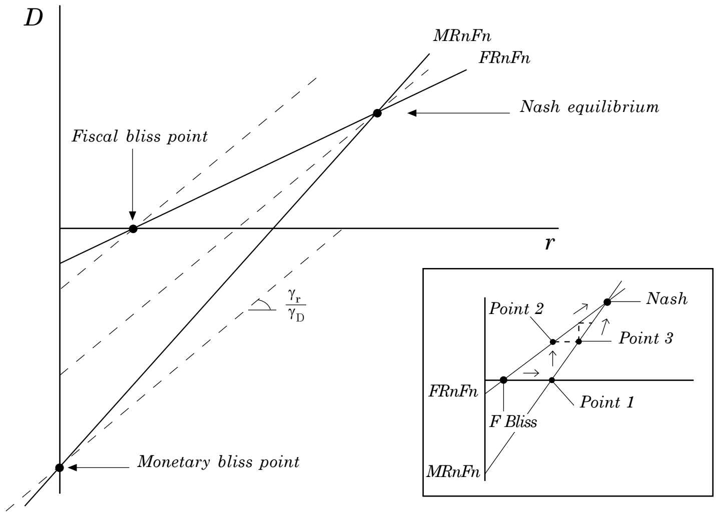
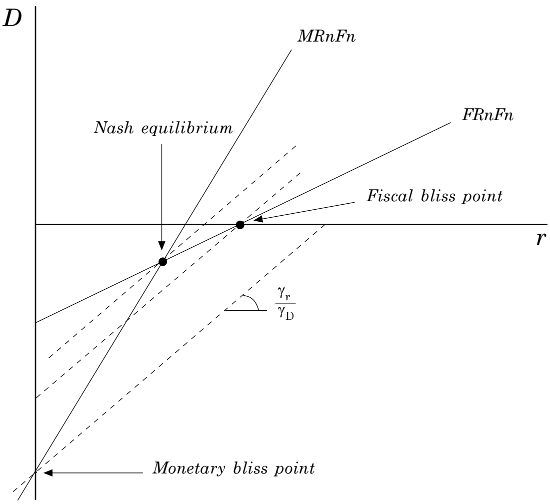


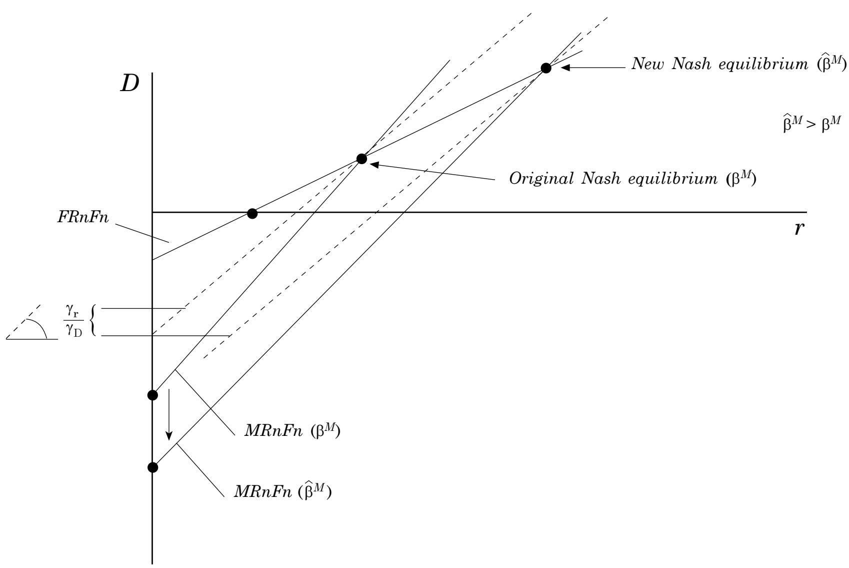
Figure 4. Nash Equilibrium when the Central Bank Sufficiently Dislikes Changing the Interest Rate



What happens if the difference in preferences between the two authorities becomes wider (that is, the difference between α^F/β^F and α^M/β^M increases)? Modeling this as a higher $\beta^M\left(\hat{\beta}^M>\beta^M\right)$ in figure 5, we can see that the new equilibrium $\left(\hat{D}^N, \hat{r}^N\right)$ will necessarily be located to the northeast of (D^N, r^N), which means higher levels of both instruments, lower inflation, and lower aggregate demand. Both the intercept and the slope of MRnFn will be lower if β^M increases to $\hat{\beta}^M$, reflecting the lower desired aggregate demand that results from the stronger anti-inflation preference of the central bank.[7] Note that this conclusion does not require the assumption made in equation (15).

To summarize, modeled as a Nash game, the uncoordinated policy reaction of the fiscal and monetary authorities to a negative supply shock results in higher fiscal deficits and higher real interest rates than those obtained when either authority alone determines both instruments. Moreover, when the divergence in the authorities' preferences for the output and inflation gaps widens, the resulting fiscal deficit becomes larger and the real interest rate becomes higher.

Figure 5. Shift in Nash Equilibrium with an Increase in the Central Bank's Preference



7. This result is maintained if we model the increased difference in preferences as a higher α^F, a lower α^M, or a lower β^F. The last two results can easily be derived from the resulting values of D^N and r^N.

Finally, substituting the resulting D^N and r^N in the output gap equation (3) and in the inflation equation (4), it can clearly be seen that equilibrium output is lower than y^* and inflation higher than π^*. In other words, the solution is interior to the range $y < y^*$ and $\pi > \pi^*$. Thus it is valid to assume that, given a negative supply shock, the authorities' utility function can be modeled as the simple quadratic form of equations (5) and (6).

1.4 The Stackelberg Equilibrium

Whereas the Nash equilibrium is obtained when both players move simultaneously, a sequential play of the game leads to the Stackelberg equilibrium. For the monetary-fiscal game this means that one of the authorities decides first the magnitude of its instrument and the other follows its lead. We begin by assuming that the monetary authority is the leader. The contrary case is analyzed at the end of this section.

In the Stackelberg game, when the central bank is the leader, the fiscal reaction will be governed by equation (9), the optimal response of the follower to a given real interest rate.

The central bank's first-order condition as the leader of the Stackelberg game is obtained by maximizing U^M with respect to r, taking into account that the central bank is now able to affect D according to the fiscal authority's reaction function in equation (9). We can then express the monetary authority's "action" function (MAnFn) as follows:

$$D = \left[1 + \frac{\tau}{\Phi\gamma_r^2\left(\alpha^M + \beta^M\lambda_y^2\right)} \right] \frac{\gamma_r}{\gamma_D} r + \left[\frac{\lambda_y\lambda_0}{\gamma_D\left(\alpha^M/\beta^M + \lambda_y^2\right)} \right], \tag{16}$$

$$\text{where } \Phi = \frac{1}{1 + \dfrac{\gamma_D^2\,(1 + \beta^F\lambda_y^2)}{\delta}} < 1 \ . \tag{17}$$

Substituting equation (9) into equation (16), we can determine the central bank's optimal magnitude for the real interest rate. Then, given r, the fiscal authority decides its deficit according to equation (9). The Stackelberg solution is given by

$$D^s = \frac{-\Phi\gamma_r^2\lambda_y\left(\alpha^F\beta^M - \alpha^M\beta^F\right)\lambda_0 + \tau\beta^F\lambda_y\lambda_0}{\Phi\gamma_r^2\delta/\gamma_D\left(\alpha^M + \beta^M\lambda_y^2\right) + \tau\delta/\gamma_D + \gamma_D\tau\left(\alpha^F + \beta^F\lambda_y^2\right)}, \tag{18}$$

$$r^s = \frac{-\Phi\gamma_D^2\lambda_y\left(\alpha^F\beta^M - \alpha^M\beta^F\right)\lambda_0 - \Phi\delta\beta^M\lambda_y\lambda_0}{\Phi\gamma_r\delta\left(\alpha^M + \beta^M\lambda_y^2\right) + \tau\delta/\gamma_r + \gamma_D^2\tau/\gamma_r\left(\alpha^F + \beta^F\lambda_y^2\right)}. \tag{19}$$

As in the Nash equilibrium, the resulting fiscal deficit, equation (18), does not strictly have to be positive. It could be negative if the authorities' preferences become very similar or if the relative cost to the central bank of a change in its instrument from the optimum rises considerably. As previously, the case of a negative equilibrium deficit has little practical importance, for it implies that central bank independence would result in a higher inflation rate with respect to the fiscal bliss point. Therefore in what follows we assume that the condition given in equation (20) holds, so that the Stackelberg equilibrium always implies larger deficits and higher real interest rates than the solutions under a single economic authority:

$$\alpha^F\beta^M - \alpha^M\beta^F > \frac{\beta^F}{\gamma_r^2\Phi}. \tag{20}$$

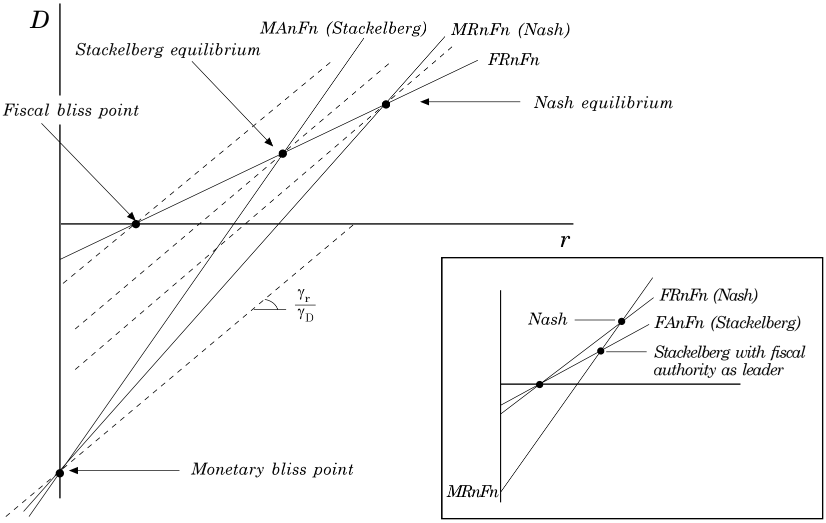
Figure 6 shows the Stackelberg equilibrium, which is the intersection between equation (16), the MAnFn (Stackelberg), and equation (9). As in the Nash solution, the lack of policy coordination, modeled as a Stackelberg game, results in larger fiscal deficits and higher real interest rates than when either authority controls both policy instruments.

What happens in this case if the difference in preferences between the two authorities becomes wider (that is, the difference between α^F/β^F and α^M/β^M increases)? As in the Nash game, modeled as higher β^M $\left(\hat{\beta}^M > \beta^M\right)$, the new equilibrium $\left(\hat{D}^S, \hat{\pi}^S\right)$ will necessarily be located to the northeast of (D^S, r^S), which means higher levels of both instruments and lower inflation and aggregate demand.[8] Note that this conclusion does not require the assumption in equation (20).

Relative to the Nash solution, the Stackelberg equilibrium produces smaller deficits and lower interest rates. When the monetary authority is the leader, it also implies a higher level of economic activity (and of inflation) and allows both authorities to reach a higher iso-utility curve than in the Nash equilibrium. The inset in figure 6 shows the alternative case in which the fiscal authority is the leader. Here the conclusions are similar except that the resulting level of aggregate demand is lower than in the Nash solution.

8. As in the Nash game, this result is maintained if we model the increased difference in preferences as a higher α^F, lower α^M, or lower β^F. The last two results can easily be derived from the resulting values of D^S and r^S.

Figure 6. Stackelberg Equilibrium with Central Bank as Leader



Finally, with the same procedure used as in the Nash game, it can clearly be seen that the Stackelberg solution is interior to the range $y < y^*$ and $\pi > \pi^*$. Thus it is valid to assume that, given a negative supply shock, the authorities' utility function can be modeled as the simple quadratic form of equations (5) and (6).

1.3 Conclusions

We have modeled the lack of coordination between fiscal and monetary authorities as, alternatively, a Nash or a Stackelberg game. Under the assumption that, compared with the fiscal authority, the monetary authority loses more from higher inflation than from a larger output gap, we reach three main conclusions. First, in the presence of a negative supply shock, lack of coordination results in a larger fiscal deficit and a higher interest rate than when either authority controls both instruments.[9]

9. This result requires, in addition, that the monetary authority be sufficiently willing to modify its instrument.

Second, when the difference in preferences between the monetary and fiscal authorities increases, so do the equilibrium fiscal deficit and interest rate. As we show in Bennett and Loayza (2000), this result holds not only for negative supply shocks, but also in the presence of aggregate demand shocks. Section 2 is devoted to testing this second conclusion of the theoretical model.

Third, when the relationship between the fiscal and monetary authorities can be represented as a leader-follower relationship, the Stackelberg solution applies. In this case the previous two conclusions are still valid, but in a milder form: the Stackelberg solution produces fiscal deficits and interest rates that are in between the policy coordination solution and the Nash equilibrium.

2. Empirical Evidence

The main conclusion of section 1 can be summarized as follows. In a context where fiscal and monetary authorities are independent and do not effectively coordinate their policy responses, those countries and time periods where these authorities have more divergent preferences for the output and inflation gaps will exhibit larger primary deficits and higher real interest rates. Given the highly simplified nature of our game-theoretic model, this conclusion would apply only after controlling for other factors affecting the level of primary deficits and domestic real interest rates.

In this section we bring to bear some empirical evidence concerning our main conclusion. We base this evidence on regressions using both cross-country and time-series data. This choice is justified by the nature of our conclusion, which compares different policy regimes both within and between countries.

2.1 The Empirical Model

Let d be the primary deficit (properly normalized to be comparable across countries and over time) and r the real domestic interest rate (or more precisely, that portion of it subject to changes in policy). Then consider the following two reduced-form regression equations:

$$d_{i,t} = \beta_d X_{i,t} + \theta_d mf_{i,t} + \varepsilon_{i,t} \ , \tag{21}$$

$$r_{i,t} = \beta_r X_{i,t} + \theta_r mf_{i,t} + \mu_{i,t} \ , \tag{22}$$

where *mf* is an indicator of the difference in preferences between monetary and fiscal authorities regarding the inflation and output gaps, *X* is a set of control variables, and the subscripts *i* and *t* denote country and time, respectively. We assume cross-country homogeneity in the response of primary deficits and real interest rates to changes in *mf* and *X*; thus the coefficients β and θ are the same across countries and over time.

Hypothesis Test

The test of our main hypothesis is based on the sign and significance of both θ_d and θ_r. If both are significantly positive, we conclude that an increase in the divergence of preferences between monetary and fiscal authorities raises, ceteris paribus, the primary deficit and the real interest rate, thus supporting our main hypothesis.

Sample

We use a pooled data set of annual observations for the period 1970-94 covering most industrialized countries. Since the paper focuses on the interaction of fiscal and monetary policies toward stabilization, we cannot use countries where the fiscal-monetary relationship has been dominated by inflationary financing of the fiscal deficit. We recognize that, in that case, the issues analyzed in this paper are of second-order importance. For that reason the sample does not include developing countries or industrial countries that have experienced relatively high inflation over the last three decades, such as Greece (where annual inflation over the period averaged 14 percent), Iceland (24 percent), and Portugal (14 percent.) For the remaining industrial countries the average inflation rate for the period has been below 10 percent. In the 1990s many developing and transition countries (notably, Argentina, Bolivia, Peru, and Poland) pursued stabilization policies that brought their inflation rates down to single digits. Insofar as these countries do not revert to using the inflation tax to finance their fiscal deficit, the issues and policy biases put forward in this paper are relevant for them. However, given that their period of stability is too recent, we do not include them in the empirical analysis. This leaves nineteen industrialized countries in the sample: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, the Netherlands, New Zealand, Norway, Spain, Sweden, Switzerland, the United Kingdom, and the United States.

Structure of the Error Terms and Method of Estimation

Regarding the characteristics of the error terms in the deficit and interest rate regressions, we work under two alternative sets of assumptions. First we assume joint endogeneity of d and r and no country random effects. We allow for the joint endogeneity of d and r by admitting a contemporaneous correlation between their respective error terms. However, we assume that each error term is uncorrelated both serially and across countries. In this case the method of estimation is Zellner's seemingly-unrelated-regression estimator (SURE) applied to pooled data:

$$E\left[\varepsilon_{i,t}, \mu_{j,s}\right] = \sigma_{\varepsilon\mu} \text{ for } i = j,\ t = s, \text{ and 0 otherwise,} \tag{23}$$

$$E\left[\varepsilon_{i,t}, \varepsilon_{j,s}\right] = \sigma_{\varepsilon\varepsilon} \text{ for } i = j,\ t = s, \text{ and 0 otherwise,} \tag{24}$$

$$E\left[\mu_{i,t}, \mu_{j,s}\right] = \sigma_{\mu\mu} \text{ for } i = j,\ t = s, \text{ and 0 otherwise.} \tag{25}$$

Alternatively, we assume joint endogeneity of d and r and country random effects. We allow for the joint endogeneity of d and r as in the previous case, but in addition we allow the error terms corresponding to the same country to be correlated. However, we retain the assumption that the error terms of different countries are uncorrelated. In this case the method of estimation is SURE applied jointly with the random effects estimator to pooled data:

$$E\left[\varepsilon_{i,t}, \mu_{j,s}\right] = \sigma_{\varepsilon\mu} \text{ for } i = j,\ t = s, \text{ and 0 otherwise,} \tag{26}$$

$$E\left[\varepsilon_{i,t}, \varepsilon_{i,t}\right] = \sigma_{\varepsilon\varepsilon}, \quad E\left[\varepsilon_{i,t}, \varepsilon_{i,s}\right] = \sigma_{R\varepsilon} \text{ for } t \neq \text{s and}$$

$$E\left[\varepsilon_{i,t}, \varepsilon_{j,s}\right] = 0 \text{ for } i \neq j, \tag{27}$$

$$E\left[\mu_{i,t}, \mu_{i,t}\right] = \sigma_{\mu\mu}, \quad E\left[\mu_{i,t}, \mu_{i,s}\right] = \sigma_{R\mu} \text{ for } t \neq s \text{ and}$$

$$E\left[\mu_{i,t}, \mu_{j,s}\right] = 0 \text{ for } i \neq j. \tag{28}$$

Dependent Variables

For the deficit regression, the dependent variable is the ratio of the central government's primary deficit (the overall deficit minus interest payments) to GDP; data are from the International Monetary

Fund's *Government Finance Statistics*. Dividing by GDP makes the scale (or metric) of the primary deficit such that it can be used for regressions across countries and over time. For the interest rate regression, the dependent variable is the domestic real interest rate minus the international rate; these are obtained, respectively, from Loayza and others (1998) and the International Monetary Fund's International Financial Statistics. We use the deviation from the international rate to account for the fact that domestic rates are heavily influenced by parity conditions in countries with open capital accounts.[10]

Control Variables

Our main hypothesis deals with only one of the many potential determinants of primary fiscal deficits and domestic real interest rates. Therefore, in order to test it we must control for other variables that influence or are influenced by primary deficits or domestic real interest rates. We use the same control variables for both regressions. To account for the real effects of the business cycle, we use both the current GDP growth rate and the deviation of that growth rate from its previous five-year average. We include the current inflation rate to control for seignorage-related factors, and its deviation from the previous five-year average to control for the price effects of the business cycle. In order to account for international conditions and shocks, we incorporate the terms of trade and the average growth rate of all industrialized countries. Finally, to control for Ricardian equivalence effects, we use the private saving rate. The data for all these variables were obtained from Loayza and others (1998).

Proxies for the Difference in Preferences

The variable whose effect on fiscal primary deficits and domestic interest rates we want to assess is the difference in preferences between monetary and fiscal authorities regarding the inflation and output gaps. We proxy for this variable with measures of the central bank's statutory commitment to control inflation, as expressed in its charter. This is appropriate under the maintained assumption that

10. Nominal domestic rates are deflated by an average of current and next-year inflation rates. The international real interest rate is the nominal Eurodollar London rate adjusted by the percentage change in the consumer price index for industrial countries.

the fiscal authorities' relative preference for output and inflation gaps does not vary much over time and across countries.

The first two proxies are based on the 1992 paper by Cukierman, Webb, and Neyapti (CWN). The first one (π *obj*) is their index of the importance of price stability as a central bank objective.[11] Data exist for this measure for most industrialized countries and many developing countries over the period 1970-89. The second proxy (π *obj-a*) results from updating the first index up to 1994. We did the update assuming that the central banks of the sample countries have not changed their stance toward inflation except when they explicitly adopted an inflation targeting regime.

The third proxy (π *targ*) is a dummy variable for whether the central bank has an explicit inflation targeting regime. Except for the case of Germany, explicit inflation targeting regimes have been adopted rather recently: in Australia (1993), Canada (1991), Finland (1993), New Zealand (1990), and Sweden (1993). In addition, we use CWN's index of central bank independence (*cbi*), exclusive of the price stability objective, in order to compare the effects of central bank independence with those of central bank preference for price stability.

2.2 Results

Tables 1, 2, and 3 present the estimation results. The first two tables use the proxies based on how important the inflation objective is for the central bank (π *obj*, π *obj-a*, and π *targ*). The third table presents the results using the index of central bank independence (*cbi*) as the explanatory variable of interest. Each table presents the regression results by pairs of the primary deficit and the real interest rate as dependent variables in each SURE system. The results reported in table 1 are for estimations performed under the assumption

11. CWN's index for the inflation objective of the central bank is based on explicit information contained in its charter. The index ranges from 0 to 1. Values are assigned according to the following criteria: 1 if price stability is mentioned as the only or major goal, and in case of conflict with the government the central bank has final authority to pursue policies aimed at achieving this goal; 0.8 if price stability is mentioned as the only goal but the central bank does not have explicit final authority in case of conflict; 0.6 if price stability is mentioned along with other objectives that do not seem to conflict with price stability (such as maintenance of a stable banking system); 0.4 if price stability is mentioned along with one or more potentially conflicting goals (such as full employment); 0.2 if the charter does not contain any objectives for the central bank; and 0 if some goals appear in the charter but stability is not one of them.

Table 1. Effects of Different Preferences between Fiscal and Monetary Authorities on Deficits and Real Interest Rates, Estimation without Country Random Effects[a]

	Dependent variable					
	SURE1		*SURE2*		*SURE3*	
Explanatory variable	*Primary deficit*[b]	*Interest rate*[c]	*Primary deficit*	*Interest rate*	*Primary deficit*	*Interest rate*
Proxy for difference in preferences[d]						
π obj	0.010	0.011				
	(2.50)	(2.29)				
π obj-a			0.012	0.013		
			(2.85)	(3.06)		
π targ					0.008	0.013
					(1.56)	(2.52)
GDP growth rate	−0.114	−0.002	−0.350	−0.162	−0.315	−0.110
	(−0.99)	(−0.02)	(−3.12)	(−1.38)	(−2.77)	(−0.93)
Deviation of GDP growth rate[e]	0.197	−0.192	0.353	−0.126	0.335	−0.163
	(1.52)	(−1.25)	(2.81)	(−0.96)	(2.62)	(−1.22)
Inflation	0.366	−0.204	0.374	−0.336	0.377	−0.323
	(9.46)	(−4.48)	(9.77)	(−8.36)	(9.47)	(−7.78)
Deviation of inflation[e]	−0.324	−0.393	−0.313	−0.33	−0.328	−0.354
	(−4.88)	(−5.02)	(−4.47)	(−4.44)	(−4.58)	(−4.72)
Terms of trade	−0.05	0.026	−0.039	0.048	−0.04	0.047
	(−3.77)	(1.68)	(−2.72)	(3.21)	(−2.8)	(3.11)

Table 1. (continued)

	Dependent variable					
	SURE1		*SURE2*		*SURE3*	
Explanatory variable	*Primary deficit*[b]	*Interest rate*[c]	*Primary deficit*	*Interest rate*	*Primary deficit*	*Interest rate*
Growth rate in OECD	−2.067	−0.386	−0.129	−0.59	−0.151	−0.612
	(−2.2)	(−3.49)	(−1.31)	(−5.7)	(−1.52)	(−5.91)
Private saving	−0.351	−0.036	0.34	−0.013	0.311	−0.043
	(−9.8)	(−0.86)	(9.42)	(−0.34)	(8.99)	(−1.20)
Constant	−0.042	−0.014	−0.048	−0.017	−0.037	−0.007
	(−2.59)	(−0.73)	(−2.75)	(−0.92)	(−2.18)	(−0.36)
R^2	0.41	0.28	0.32	0.42	0.31	0.41
N	348	348	438	438	438	438

Source: Authors' calculations.
a. Data are annual data for nineteen industrial countries from 1970 to 1994. The estimator is Zellner's seemingly-unrelated-regression estimator. Numbers in parentheses are t statistics.
b. As a percentage of GDP.
c. Difference between the domestic and the international interest rates.
d. π *obj* is an index of the importance of price stability as a central bank objective for the period 1970-89, taken from Cukierman, Webb, and Neyapti (1992); π *obj-a* is the same index updated to 1994; π *targ* is a dummy variable for whether the central bank has an explicit inflation targeting regime.
e. Deviation from its previous five-year average.

Table 2. Effects of Different Preferences between Fiscal and Monetary Authorities on Deficits and Real Interest Rates, Estimation with Country Random Effects[a]

	Dependent variable					
	SURE1		*SURE2*		*SURE3*	
Explanatory variable	*Primary deficit*[b]	*Interest rate*[c]	*Primary deficit*	*Interest rate*	*Primary deficit*	*Interest rate*
Proxy for difference in preferences[d]						
π *obj*	0. 011 (1.39)	0. 014 (1.90)				
π *obj-a*			0.017 (2.52)	0.014 (2.37)		
π *targ*					0.012 (1.85)	0.009 (1.46)
GDP growth rate	−0.189 (−1.62)	0.184 (1.37)	−0.518 (−4.44)	−0.016 (−0.13)	−0.51 (−4.24)	0.001 (0.01)
Deviation of GDP growth rate[e]	0.246 (1.92)	−0.371 (−2.50)	0.504 (3.92)	−0.303 (−2.31)	0.500 (3.83)	−0.309 (−2.30)
Inflation	0.377 (8.18)	−0.155 (−3.02)	0.382 (9.19)	−0.374 (−8.89)	0.388 (9.05)	−0.372 (−8.54)
Deviation of inflation[e]	−0.323 (−4.80)	−0.469 (−6.05)	−0.282 (−4.04)	−0.321 (−4.47)	−0.297 (−4.17)	−0.333 (−4.54)
Terms of trade	−0.05 (−3.51)	0.003 (0.16)	−0.04 (−2.74)	0.027 (1.78)	−0.04 (−2.72)	0.026 (1.72)

Table 2. (continued)

	Dependent variable					
	SURE1		*SURE2*		*SURE3*	
Explanatory variable	*Primary deficit*[b]	*Interest rate*[c]	*Primary deficit*	*Interest rate*	*Primary deficit*	*Interest rate*
Growth rate in OECD	−0.177	−0.352	−0.079	−0.556	−0.095	−0.571
	(−2.02)	(−3.43)	(−0.84)	(−5.68)	(−1.01)	(−5.85)
Private saving	0.30	−0.108	0.341	−0.044	0.319	−0.068
	(5.99)	(−2.04)	(6.90)	(−6.60)	(8.99)	(−1.46)
Constant	−0.03	0.014	−0.046	0.008	−0.036	0.018
	(−1.68)	(0.69)	(−2.48)	(0.41)	(−1.99)	(1.01)
R^2	0.51	0.41	0.42	0.51	0.42	0.50
N	348	348	438	438	438	438

Source: Authors' calculations.
a. Data are annual data for nineteen industrial countries from 1970 to 1994. The estimator is Zellner's seemingly-unrelated-regression estimator. Numbers in parentheses are t statistics.
b. As a percentage of GDP.
c. Difference between the domestic and the international interest rate.
d. Proxy measures are defined as in table 1.
e. Deviation from its previous five-year average.

Table 3. Effects of Central Bank Independence on Deficits and Real Interest Rates[a]

	Dependent variable			
	Without country random effects		*With country random effects*	
Explanatory variable	*Primary deficit*[b]	*Interest rate*[c]	*Primary deficit*	*Interest rate*
Index of central bank independence[d]	−0.004 (−0.44)	0.025 (2.31)	0.0003 (0.02)	0.014 (1.11)
GDP growth rate	−0.11 (−0.95)	0.082 (0.59)	−0.193 (−1.64)	0.231 (1.70)
Deviation of GDP growth rate[e]	0.204 (1.53)	−0.25 (−1.61)	0.257 (1.99)	−0.40 (−2.66)
Inflation	0.35 (8.15)	−0.16 (−3.18)	0.378 (7.87)	−0.122 (−2.23)
Deviation of inflation[e]	−0.317 (−4.49)	−0.455 (−5.53)	−0.327 (−4.73)	−0.51 (−6.38)
Terms of trade	−0.052 (−3.93)	0.025 (1.63)	−0.051 (−3.54)	−0.001 (−0.10)
Growth rate in OECD	−0.214 (−2.26)	−0.403 (−3.64)	−0.181 (−2.07)	−0.35 (−3.48)
Private saving	0.326 (9.41)	−0.069 (−1.70)	0.286 (5.83)	−0.153 (−2.78)
Constant	−0.028 (−1.67)	−0.016 (−0.83)	−0.023 (−1.22)	0.023 (1.06)
R^2	0.39	0.28	0.51	0.42
N	348	348	348	348

Source: Authors' calculations.

a. Data are annual data for nineteen industrial countries from 1970 to 1994. The estimator is Zellner's seemingly-unrelated-regression estimator. Numbers in parentheses are t statistics.

b. As a percentage of GDP.

c. Difference between the domestic and the international interest rate.

d. From Cukierman, Webb, and Neyapti (1992).

e. Deviation from its previous five-year average.

of homoskedasticity and independence across countries and over time, whereas those in table 2 are obtained using a country random-effects model. Table 3 presents both estimation methods for the case of *cbi* as the explanatory variable.

The estimation results presented in tables 1 and 2 broadly support our main hypothesis. When we control for shocks and economic conditions that influence primary deficits and the real interest rate, those countries and time periods where the central bank places greater importance on keeping inflation down are associated with both larger primary deficits and higher real interest rates. In the case of π *obj-a*, the proxy with the largest coverage and signal variance, its effect on both the primary deficit and the real interest rate is positive and significant at the 5 percent level. The sign, significance, and even the size of the coefficients on this variable are virtually the same whether country random effects are ignored (table 1) or controlled for (table 2). The estimated coefficients with the random-effects model imply that a one-standard-deviation increase in π *obj-a* is associated with both an increase in the primary deficit of 0.56 percent of GDP and a rise in the domestic real interest rate by 0.46 percentage point over the international rate.

The results obtained with the other two proxies for the central bank's concern for price stability, π *obj* and π *targ*, are fairly similar. The estimated coefficients are always positive. In most cases they are also statistically significant at conventional thresholds (5 or 10 percent), and in the rest they are at least marginally significant (the largest p value is 0.17).

In table 3 we study whether a measure of central bank independence renders the same results as measures of central bank's concern for price stability. We find no significant effects of central bank independence on primary deficits under either estimation method. Central bank independence does have a positive and significant effect on real interest rates when homoskedasticity and independence of the error term are assumed. However, the statistical significance of this result vanishes when country random effects are allowed for. Comparing the results of table 3 with those of tables 1 and 2, we conclude that having an independent central bank is not by itself conducive to the policy biases that result from lack of policy coordination. The key issue is the divergence of objectives (revealing different preferences) between fiscal and monetary authorities.

Finally, a note of caution. In the empirical exercises presented here, we have proxied the divergence in preferences between fiscal and monetary authorities with measures of the central bank's concern with price stability. However, policy implications should be derived with respect to the variable of interest (the difference in preferences) and not with respect to its proxy. We worked under the assumption that fiscal authorities' preferences are relatively constant across countries and over time. We adopted this empirical approach for convenience, given that it is easier to find empirical measures for central bank's objectives than for those of fiscal authorities. Thus, our empirical results should not be taken to imply that, in order to reduce the described policy biases, the central bank should unilaterally lower its standards for inflation control. Rather, the policy implication we favor is that coordination, both at the level of setting objectives and at the level of policy implementation, can alleviate the biases that move the economy to suboptimally higher fiscal deficits and real interest rates.

3. Conclusions

Central bank independence has contributed to the achievement of price stability and fiscal discipline in many countries. The conventional wisdom is that this is a necessary, first-generation reform of fiscal and monetary policy. The question this paper asks is whether a second-generation reform consisting of institutional incentives for domestic policy coordination could be beneficial. The paper presents a game-theoretic model in which the fiscal and monetary authorities interact to stabilize the economy, starting from dissimilar preferences with respect to the output and inflation gaps and controlling different policy instruments. It is assumed, realistically, that the monetary authority experiences a relatively larger utility loss from inflation than output gaps than the fiscal authority does.

Modeled as either a Nash or a Stackelberg equilibrium, the solution under the assumption of lack of policy coordination implies that, in the face of a negative supply shock, the fiscal authority acts more liberally and the monetary authority more conservatively than if either controlled both policy instruments. Moreover, we find that an increase in the divergence of preferences between the monetary and fiscal authorities leads to, ceteris paribus, larger public deficits (the fiscal authority's policy instrument) and higher real interest rates (the central bank's instrument).

The paper's empirical analyses attempt to test the latter conclusion on a pooled sample of nineteen industrial countries with annual data for the period 1970-94, using the seemingly-unrelated-regression estimator and allowing for country random effects. Working under the assumption that fiscal authorities' relative preference for output and inflation gaps varies little over time and across countries, we proxy for the divergence in preferences with measures of the central bank's commitment to control inflation. Controlling for other shocks and economic conditions, we find that countries and time periods where the central bank places a greater importance on keeping inflation low are associated with both larger primary deficits (as a ratio to GDP) and domestic real interest rates (as a deviation from international rates).

The empirical results of the paper should not be taken to imply that, in order to reduce these policy biases, which move the economy to suboptimally large fiscal deficits and high real interest rates, the central bank should unilaterally lower its standards for inflation control. Rather, the policy implication we favor is that, without prejudice to the gains from central bank independence, coordination both at the level of setting objectives and at the level of policy implementation can alleviate these biases. This goal must be achieved with "second generation" reforms. These must deal with the issues that hinder the process of coordination, such as contract enforceability, transactions costs, and the practical inability to discern outcomes due to policies from those due to shocks.

References

Bennett, H., and N. Loayza. 2000. "Policy Biases When The Monetary and Fiscal Authorities Have Different Objectives." Working Paper 66. Santiago: Central Bank of Chile.

Bernanke, B. S., T. Laubach, F. Mishkin, and A. Posen. 1999. *Inflation Targeting. Lessons from the International Experience.* Princeton, N.J.: Princeton University Press.

Cukierman, A. 1992. *Central Bank Strategy, Credibility, and Independence: Theory and Evidence.* Cambridge, Mass.: MIT Press.

Cukierman, A., S. B. Webb, and B. Neyapti. 1992. "Measuring the Independence of Central Banks and Its Effect on Policy Outcomes." *World Bank Economic Review* 6(3): 353-98.

Frankel, J. A. 1988. "The Implications of Conflicting Models for Coordination between Monetary and Fiscal Policymakers." In *Empirical Macroeconomics for Interdependent Economies,* edited by R. C. Bryant and others. Washington: Brookings Institution.

Loayza, N., H. López, K. Schmidt-Hebbel, and L. Servén. 1998. "The World Saving Database." Washington: World Bank.

Loewy, M. 1988. "Reganomics and Reputation Revisited." *Economic Inquiry* 26 (April): 253-63.

Nordhaus, W. 1994. "Policy Games: Coordination and Independence in Monetary and Fiscal Policies." *Brooking Papers on Economic Activity* 2: 139-215.

Perry, G., and D. Lederman. 1997. "The Importance of Macroeconomic Policy Coordination: A Note." Unpublished paper. Washington: Office of the Chief Economist, Latin America and the Caribbean, World Bank.

Walsh, C. E. 1993. "Central Bank Strategies, Credibility and Independence: A Review Essay." *Journal of Monetary Economics* 32: 287-302.

Woodford, M. 1999. "Optimal Monetary Policy Inertia." NBER Working Paper 7261. Cambridge, Mass.: National Bureau of Economic Research (August).